THREE-DIMENSIONAL OPTICAL MEMORY WITH FLUORESCENT PHOTOSENSITIVE MATERIAL

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Technical field

The present invention relates to a three-dimensional optical memory with fluorescent photosensitive materials and more particularly to a method and device for storage and retrieval digital data, using fluorescence phenomenon. The device presented in the invention is a WORM type storage system (write-once-read-many).

Background of the invention

It is known that the growing of computer applications has imposed the necessity for memories with huge storage capacity needed for libraries, government agencies, hospitals, etc.The new memories should have the following characteristics: low-cost, small size and low energy consumption.

Present memory technologies, such as semiconductor memories, CD-ROMs, rigid and flexible magnetic disks, and magnetic tape store information on a two-dimensional support.Due to their 2-D nature, these memories are not able to provide parallel access, and their access time grows with increasing capacity.

A solution is the use of the third dimension. Three-dimensional optical memories have higher theoretical storage capacity than present 2-D memories.

For example, the maximum theoretical storage density for an optical disk is $1/\lambda^2 = 3.5\times10^8$bits/cm^2, while for a 3-D memory $1/\lambda^3 = 6.5\times10^{12}$bits/cm^3 assuming that the same wavelength of light $\lambda = 500$ nm is used to access the information. In addition, 3-D optical memory have the potential for parallel access, because an entire plane can be read or written in a single operation. 3-D data storage was experimented on holographic memories made by photorefractive materials (D. Psaltis and F. Mok, **Scientific American**, November 1995, p.52).

Summary of the invention

It is the object of the present invention to employ the fluorescence phenomenon to provide a WORM type 3-D optical memory. Since the read cycle uses fluorescence rather than changes in absorption a higher sensibility is obtained.

The invention is based on writing and reading the information in fluorescent photosensitive materials namely fluorescent photosensitive glasses (E. Pavel, L. Tugulea, Journal of Solid State Chemistry, **134**, 362, (1997); E. Pavel et. al., Optics Letters, **23**, 1304, (1998)) and fluorescent photosensitive vitroceramics created by the author of present invention. Writing and reading of said data are carried out with a confocal microscope. The confocal principle was invented by Marvin Minsky, U.S. Patent No. 3,013,467. A point light source is imaged in the object plane. The emitted fluorescent light is directed to a photomultiplier through a detector pinhole. The pinhole is a spatial filter, which permits the analyzing of the light issued only from the focal plane containing this object. This fact ensures obtaining an improved spatial resolution. A computer displays the point as a pixel on a screen. In order to produce a complete image, the light point is moved over the entire object. The arrangement of the detector pinhole, conjugated to the illumination pinhole, ensures that only information from the focal plane reaches the detector. The confocal principle is especially valuable in fluorescence microscopy, since it almost completely eliminates stray light not coming from focal plane.

Thus the system is able to produce fluorescence images with optimum clarity and resolution of fine details. Confocal system LEICA TCS NT achieves an x-/y-resolution of 0.18μ (FWHM) and a corresponding z-resolution of better than 0.35μ (FWHM) at λ = 488 nm and N.A. = 1.32. The analyzed volume of the sample is under 1 μm^3. An improvement of the fluorescence microscopy has been obtained with two-photon process which is used for the excitation of fluorescent photosensitive material. The two-photon microscopy is a non-linear technique that provides intrinsic three-dimensional resolution with negligible out-of-focus photoexcitation. A similar result is obtained if the excitation beam is perpendicular to the fluorescence beam. The writing process consists of the irradiation of fluorescent photosensitive material with a radiation producing a fluorescence modification in the irradiated areas. The reading is obtained by the excitation of material. Non-irradiated areas have a strong fluorescence.

Invention presents the advantage of a novel device for storage and retrieval data having application in computers.